NASA Innovative Advanced Concepts

Venus Interior Probe Using In-situ Power and Propulsion (VIP-INSPR)

Completed Technology Project (2016 - 2017)

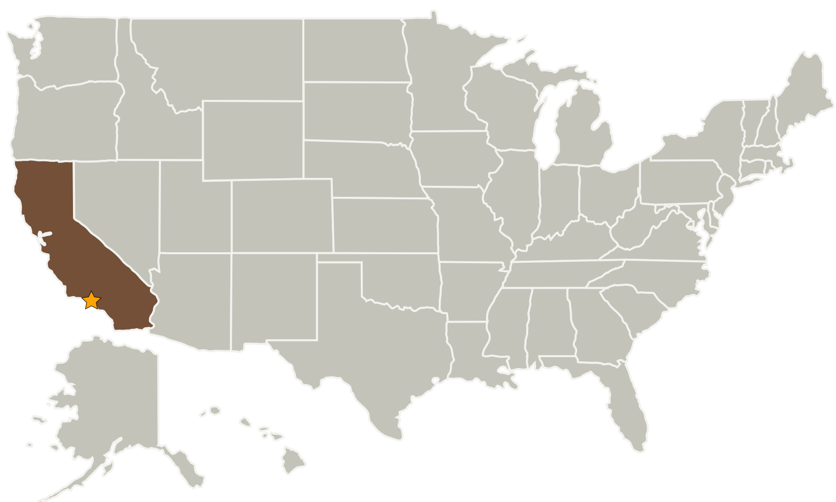
Project Introduction

We envision a novel architecture for Venus Interior Probes based on in-situ resources for power generation (VIP-INSPR). Proposed Venus probe is based on the generation of hydrogen from electrolysis at high altitudes using solar array, storing it in chemical hydride, utilizing it for altitude control in a balloon system and for power generation in fuel cell at lower altitudes. It is a challenge to have a durable power source in the low altitude environments, due to low solar intensity and low efficiency of RTG is inefficient. Primary batteries survive only for 1-2 hours. VIP-INSPR will refill hydrogen on one end and provide power on the other side continuously, thus enabling sustained exploration of the Venus atmosphere.

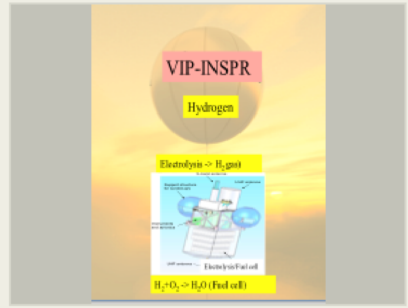
Anticipated Benefits

VIP-INSPR will refill hydrogen on one end and provide power on the other side continuously, thus enabling sustained exploration of the Venus atmosphere.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California



The Venus Interior Probe could lead to new methods of power generation for planetary missions to Venus or for Earth applications.

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Primary U.S. Work Locations

California

Project Transitions

July 2016: Project Start

June 2017: Closed out

Closeout Summary: To summarize, we have made good progress on all the individual tasks outlined in the Phase-I schedule. Task 1: Level 1 Requirements of the Venus Probe: We have formulated requirements for the Venus probe, which include: Power of 2 kWh, payload of 150 kg, hydrogen as the lifting gas, altitude cycling between 55-65 and 10-15 km from the surface and longevity for the balloon and probe. Task 2: Select suitable component Technologies: Selected suitable components technologies for the fuel cells (SOFC) in the regeneration mode to function as fuel cell and electrolyzer. Task 3: Design Electrolyzer cell and select PVs: Estimated the durations for harvesting hydrogen from the in-situ resources. SOA solar arrays with good thermal stability will be utilized. Task 4: Identify suitable metal hydrides for 25-350 C: Based on the analyses, magnesium based metal hydrides (Mg2Ni and Mg2Fe) as well as Fe-Ti seem to be suitable or these environments. A dual hydrogen storage system will be used to cater to the wide range of temperatures and pressures. Task 5: Design the Intermediate Temp Fuel Cell (350 C): Instead of a low-TRL Intermediate Temperature Fuel Cell (at 350 C), it appears that a solid oxide fuel cell would be a better option due to its high TRL and proven stability at high temperatures. Task 6: Identify compatible materials for balloon: Suitable materials have been identified for the Zero-pressure balloon with hydrogen as the lifting gas. Task 7: Generate performance data on electrolyzer, hydrides, fuel cell and balloon by test or analysis: Detailed analysis have been performed on the electrolyzer, hydrogen storage materials, fuel cells and balloon ascent and descent modes. Task 8: Integrate the components and assess system-level compatibility, analyze test data and assess the tech maturity of the probe and submit Final Report: A detailed model has been performed to determine the viability of the overall system. Quantitative estimates were made on the hydrogen transfer in and out of the balloon for its ascent and descent. Also, the probe is being designed for payload of 150 kg and a low-altitude power of 2 kWh. This report will be updated after a completion of the Phase-I.

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

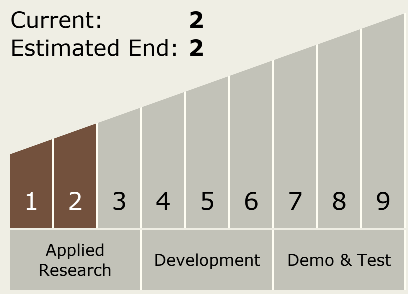
Eric A Eberly

Principal Investigator:

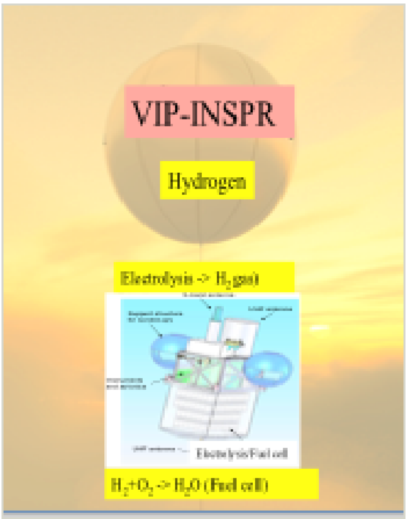
Ratnakumar V Bugga

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



Images



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The Venus Interior Probe could lead to new methods of power generation for planetary missions to Venus or for Earth applications.
(https://techport.nasa.gov/image/102307)

Project Website:

https://www.nasa.gov/directorates/spacetech/niac/index.html#.VQb6I0jJzyE

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  └ TX03.1 Power Generation and Energy Conversion
    └ TX03.1.4 Dynamic Energy Conversion

Target Destination

Others Inside the Solar System